

Study Background

This alternative fuel vehicle (AFV) demonstration project is sponsored by the U.S. Department of Energy (DOE) and managed by DOE's National Renewable Energy Laboratory (NREL). NREL designed "focus fleet studies" to provide objective information on real-world fleet experiences with AFVs. For these studies, we collect detailed operating and maintenance records and cost data, then analyze the data. Project goals are to evaluate the cost of operating AFVs, in comparison to gasoline vehicles, and to assess the performance and reliability of these vehicles.

Ideally, such a fleet would accumulate high annual vehicle mileage (50,000 or more miles on each vehicle) to enable the results of study to be made available relatively quickly (in 12 to 18 months). High mileage accumulation also allows multiple emissions tests to be included in the data collection effort. We analyze the emissions results to compare the air quality impacts of the study vehicles and to determine their levels of emissions deterioration over time.

In this interim overview, we summarize study results for this focus fleet study with Barwood Cab Company, Inc. Results based on data collected through December 1997 and from the first complete set of emissions tests are briefly described.

Barwood Cab Focus Fleet Study



Interim Summary

The Barwood Project

The participants in this project are the Barwood Cab Company, which is operating the vehicles and supplying the data; Mardi John of George Madison University, who is collecting and submitting the data to NREL; and

Environmental Research and Development, which is performing the emissions tests. Data are being collected from 20 cabs operating in the suburban Maryland area of Washington, D.C. All the vehicles in the study are 1996 Ford Crown Victorias: 10 are dedicated compressed natural gas (CNG) models, and 10 are standard gasoline models.

Barwood Cab, based in Kensington, Maryland, is a family-owned company that has been in business for more than 60 years. Barwood currently operates a fleet of more than 400 vehicles (including cabs, shuttle buses, and limousines), in Montgomery County, Maryland, with contract service in Washington D.C., and in Virginia.

The project involves collecting 12 months of operating and maintenance records and cost information from all 20 vehicles. All scheduled and unscheduled maintenance and repair records, as well as fuel use records, are being collected.

In addition, emissions tests are to be conducted on 14 of the vehicles (7 CNG and 7 gasoline) at three high-mileage intervals. The tests are scheduled at odometer levels of 60,000 miles, 90,000

1996 Crown Victoria General Specifications		
	CNG model	Gasoline model
Engine	4.6L V8	4.6L V8
Fuel capacity	10 gal (gasoline equivalent)	20 gal
Compression ratio	10:1	9:1
Estimated mpg: city	17	17
highway	25	25
Curb weight	3814 lb	3780 lb
Trunk volume	14 cu ft	20.6 cu ft

miles, and 120,000 miles, and follow the EPA's Federal Test Procedure (FTP-75). The FTP-75 is one of the test procedures the EPA uses to certify vehicles for emissions and to estimate the city fuel economy. The test includes both exhaust and evaporative emissions determinations.

Interim Study Results

Key Highlights

- The operational data we have collected and analyzed to date are encouraging for the prospect of using a dedicated CNG vehicle in this type of application.
- The preliminary data indicate that both fuel costs and maintenance costs are lower for the CNG vehicles than for the same gasoline-only vehicles that Barwood operates.
- For CNG, the average regulated emissions (nonmethane hydrocarbons [NMHC], carbon monoxide [CO], and oxides of nitrogen [NO_x]), for tests at ~60,000 miles, remained below the 100,000-mile ultra-low emission vehicle (ULEV) emissions standard.
- For reformulated gasoline (RFG), the average regulated emissions remained below the 50,000-mile Tier 1 standards, with the average NO_x being lower than the 100,000-mile ULEV standard.

Operational Data Results

Through December 1997, the CNG study vehicles had accumulated anywhere from 45,000 to 100,000 miles. The gasoline vehicles had accumulated from 74,000 to 98,000 miles. The data obtained to date and our preliminary analysis of that data indicate some differences in the costs associated with operating the CNG cabs compared to the gasoline cabs.

The fleet's operating costs were approximately 32% lower for the CNG vehicle than for the gasoline model. These results are very encouraging; however, remember that this is an initial look at the data, and the final detailed analysis of the complete data set may reveal somewhat different results.

Fuel economy differences between the CNG and gasoline vehicles are somewhat surprising, because the vehicles were operated in the same types of service, and the EPA-estimated fuel economy numbers for the two vehicles are the same.

Parameter	CNG model ¹	Gasoline model ¹
Miles accumulated per month	6272	6037
Fuel economy (mpg)	17.1	14.8
Fuel costs (cents per mile)	5.3	8.3
Maintenance and repair costs (cents per mile)	2.2	2.8
Total operating costs (cents per mile)	7.5	11.1

¹Reflects average for all vehicles in this category, summary through 12/97

Because there have been errors in the drivers' fuel use logs, we have some concerns about the validity of the fuel economy numbers for the gasoline vehicles. We will do a detailed review of all fueling records before we complete the final project data analysis.

Our data analysis revealed differences in maintenance costs. For example, the gasoline vehicles in the fleet needed more brake- and tire-related repairs. The average number of unscheduled repairs, on an annual basis, is slightly more than four per vehicle for the gasoline vehicles, compared to just over two per vehicle for the CNG vehicles.

Emissions Results

Both the CNG and the gasoline vehicles were tested on fuels that were specially blended for the NREL emissions testing program. The CNG was blended to represent an industry-average blend, and the gasoline used was California Phase II RFG. RFG emissions represent a "best case" scenario for gasoline. Here is a summary of the average results for

Regulated Constituent (g/mi)	CNG Average (g/mi)	RFG Average (g/mi)	Tier I – 100,000 mile standard (g/mi)	ULEV – 100,000 mile standard (g/mi)
NMHC	0.055	0.125	0.31	0.055
CO	0.928	2.764	4.2	2.1
NO _x	0.243	0.263	0.6	0.3

regulated emissions from the first round of emissions testing (at ~60,000 miles).

The average regulated emissions (CO, NMHC, and NO_x) were all lower for the CNG vehicles than for the gasoline vehicles tested on RFG.

- Average NMHC and CO from CNG were 56% and 66%, respectively, lower than from RFG (these averages were statistically different at 95% confidence interval).
- Average NO_x emissions from CNG were 7.6% lower than from RFG, but the two averages were not statistically different at the 95% confidence interval.
- Average CNG results were below the 100,000-mile ULEV emissions standard for NMHC, NO_x and CO. Average RFG emissions were above the ULEV standards, but well within the 100,000-mile Tier I standard.

Issues

Although Barwood's experience with dedicated CNG vehicles has been positive from a performance, economic, and environmental (emissions) standpoint, some issues did arise from operating these vehicles:

- Drivers expressed frustration with the availability of and access to fueling stations in the Washington, D.C., metro area.
- The cab company reported instances of drivers losing fares, because of the reduced trunk space in the CNG vehicle. The company has indicated that a dedicated CNG minivan may better meet its needs.

The good news is these vehicles are meeting Barwood's basic needs. We will make final results from this study available late this year.